A REPORT ON THE TROPHIC STATUS OF SIX LAKES ON THE WINNIPEG RIVER (1978 - 1982)

By

C. Hughes

Basic Trophic Assessment Sub-Program
Water Standards and Studies Section
Environmental Management Services Branch
Environmental Management Division

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INTRODUCTION

The Public Participation Program was initiated in 1978 in response to requests for water quality information by concerned cottage owners on many of the recreational lakes in Manitoba. Previous studies have shown that the enrichment (trophic) status of a lake can be estimated by the use of Secchi disc readings (transparency) and chlorophyll a concentrations (the green pigment in algae) which indicate water clarity and algal densities, respectively. The determination of the trophic status of lakes is vital to the classification of those lakes for management purposes, restoration, protection and site specific monitoring.

Volunteers are supplied with sampling kits which include a Secchi disc, a composite water sampler, one litre bottles, magnesium carbonate preservative and instructions. Participants are requested to take weekly Secchi disc measurements and samples during the ice free period of the year. Water samples are preserved and shipped to the Technical Services Laboratory in Winnipeg, where they are analyzed for chlorophyll a. Analyses of the chlorophyll a and Secchi disc results reveal the relative trophic status of each lake. Long term sampling over a number of years is useful in the detection of trends related to nutrient enrichment.

It is essential that a sampling program on a lake be continued over a period of five to ten years in order to determine if there is a trend toward accelerated enrichment. In many lakes, temporary degradation of water quality occurs during periods of extensive algal blooms. The fluctuation in algal populations occurs both seasonally and from year to year, and is caused by environmental factors such as sunlight and chemical and biological activity. Over the long term, however, definite increases in chlorophyll a would be indicative of accelerated enrichment (eutrophication) which could be induced by the addition of man generated nutrients.

Sources of nutrients are sink and laundry wastes and seepage from septic tank systems and pit privies. All lake users should be aware of the potential problems which can be caused by these sources of nutrients and that they can contribute to the impairment of recreational and aesthetic water quality. If, over the long term, it becomes apparent that man generated nutrients are contributing to accelerated eutrophication, then the sources would have to be identified and steps would have to be taken to minimize their effects.

This report includes a map or maps showing stations, weekly chlorophyll a and Secchi disc values, mean annual chlorophyll a and Secchi disc values and trophic state indices. The trophic state indices (0-100), developed by Carlson (1977), are derived from mean annual chlorophyll a and Secchi disc values.

NOTE: Water taken from lakes for domestic uses should be boiled or disinfected and, as is stated in the Public Health Act of Manitoba,

"All surface waters should be considered unsafe for domestic purposes unless boiled or otherwise disinfected..."

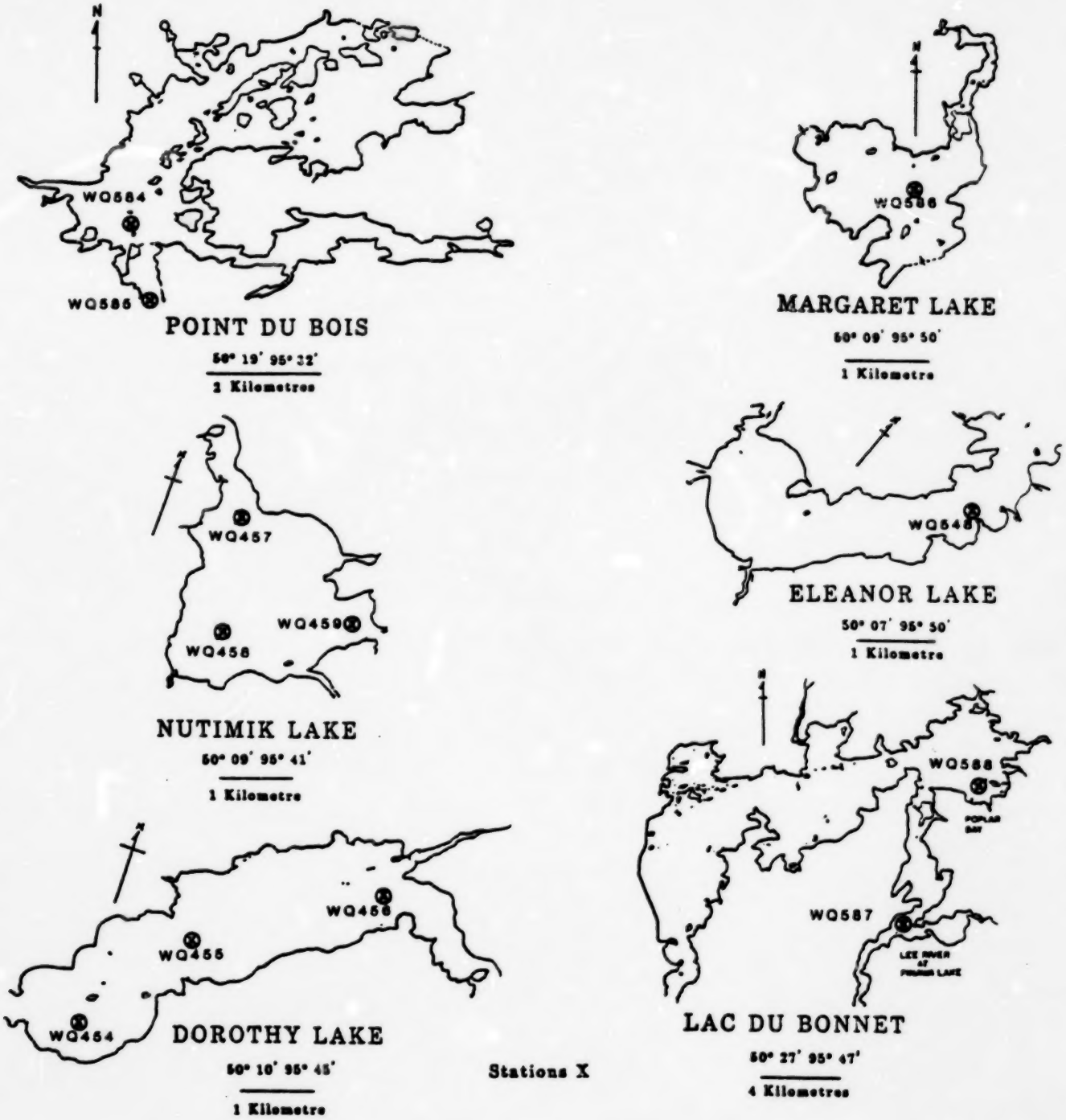

Figure 1: Location of water quality stations at six lakes and the Lee River on the Winnipeg River.

RESULTS AND DISCUSSION

During the summer of 1981, chlorophyll a and Secchi disc data were collected at eight stations on the Winnipeg River and these included: two stations, WQ584 above the dam and WQ585 below the dam at Pointe du Bois; station WQ459 at Nutimik Lake; stations WQ454 and WQ456 at Dorothy Lake; station WQ586 at Margaret Lake; station WQ548 at Eleanor Lake; station WQ587 on the Lee River at Pinawa Lake, upstream of Lac du Bonnet and station WQ588 at Poplar Bay on Lac du Bonnet (Figure 1). The first chlorophyll a and Secchi disc data collected on the Winnipeg River was carried out at six stations on Nutimik and Dorothy Lake in 1979. In 1980 only three stations were sampled, one on each of Nutimik, Dorothy and Eleanor Lakes. In 1981 and 1982 some eight and ten stations, respectively were sampled along the Winnipeg River between Pointe du Bois and Poplar Bay on Lac du Bonnet. The 1979 mean weekly chlorophyll a and Secchi disc results for Nutimik and Dorothy Lake are presented in Table 1. Individual weekly results for each station sampled at Point du Bois, Nutimik Lake, Dorothy Lake, Margaret Lake, Eleanor Lake and at or near Lac du Bonnet are shown in Tables 1, 2, 3 4, 5, and 6, respectively.

The mean annual chlorophyll a was indicative of nuisance algae populations in the Winnipeg River during 1979 but from 1980 through 1982 algae populations were generally at moderate and acceptable levels (Table 7, Figure 2). The mean annual chlorophyll a at stations sampled on Nutimik and Dorothy Lakes ranged from 14.2 to 16.6 ug/l in 1979 and in 1980 mean chlorophyll a dropped to 5.2 ug/l in Nutimik Lake and 5.4 ug/l in Dorothy and Eleanor Lakes. In 1981 and 1982 mean chlorophyll a ranged from 2.8 to 6.7 ug/l at stations located at Pointe du Bois through Eleanor Lake. The Lee River and Poplar Bay in Lac du Bonnet had high mean chlorphyll a levels of 11.3 and 10.3 ug/l in 1981 but this dropped substantially to 8.0 and 3.2 ug/l, respectively in 1982.

Secchi disc values were generally relatively stable with annual means ranging from 1.3 to 2.0 ug/l (Table 5, Figure 2).

However, considerably higher Secchi disc values were noted in Margaret Lake and lower values were noted in the Lee River. Mean annual Secchi disc values of 2.9 and 2.8 were noted in Eleanor Lake in 1981 and 1982, respectively, and this was indicative of good water transparency. The low mean annual Secchi disc values of 0.8 ug/l and 1.1 ug/l in the Lee River are probably due mainly to turbidity created by current, although algae levels would have some effect on the water transparency.

Carlson's (1977) trophic status indices (TSI) for chlorophyll a and Secchi disc are noted for each station from 1979 through 1981 (Table 4). The 1980, 1981 and 1982 TSI's for chlorophyll a ranged from 40.8 to 54.4 which was indicative of the mesotrophic to eutrophic or moderately enriched to enriched character of these lakes and of the Lee River. The TSI's for chlorophyll a in 1979 ranged from 56.6 to 58.1 indicating a greater degree of enrichment. Excluding the TSI of 63.6 for the Secchi disc on the Lee River in 1981 the TSI's for Secchi disc ranged from 44.8 to 58.6 which would tend to confirm the mesotrophic to eutrophic status established by the 1980, 1981 and 1982 chlorophyll a TSI's. Peak chlorophyll a as noted in 1979 can be expected on occasion and subsequent data collection will be required in order to delineate unusual occurrences and document any permanent change in trophic status.

Table 1. Chlorophyll a (Chlor a in ug/l) and Secchi disc (S.D. in m) values for Stations WQ584, and WQ585 (above and below the dam) at Pointe du Bois during 1981 and 1982.

Date	Station WQ584		Station WQ585	
	Chlor. a ug/l	S.D. m	Chlor. a ug/l	S.D. m
1981				
June 2	3.1	3.0		
June 7	2.5	1.6		
June 14	2.7	2.0		
July 5	2.9	1.9		
Aug. 3	7.7	1.8		
Aug. 9	4.4	2.0		
Aug. 16	4.5	1.8		
Aug. 23	7.8	2.0		
Aug. 30	14.6	1.5		
Sept. 7	15.9	1.5		
1982				
May 24	-	-	31.2	1.6
May 30	4.0	1.5	4.3	2.0
June 6	-	-	4.1	2.0
June 8	3.5	1.8	-	-
June 13	5.6	1.8	-	-
June 20	4.4	1.5	3.5	2.0
June 27	3.2	1.8	2.4	1.7
July 4	-	-	4.2	1.9
July 11	-	-	4.5	1.6
July 12	4.6	2.0	-	-
July 18	5.8	1.3	-	-
July 19	-	-	3.8	1.7
July 25	8.1	1.3	4.2	1.5
Aug. 2	5.7	1.3	6.4	1.4
Aug. 8	-	-	-	-
Aug. 15	7.7	1.3	-	-
Aug. 22	11.0	1.3	-	-
Aug. 29	4.3	1.0	-	-
Aug. 30	-	-	4.8	1.0
Sept. 6	-	-	NA	1.2

* Not Analyzed.

Table 2. Chlorophyll a (Chlor a in ug/l) and Secchi disc (S.D. in m) values for Stations WQ459, WQ458 and WQ459 in Nutimik Lake from 1979 through 1982.

Date	Station WQ457		Station WQ458		Station WQ459	
	Chlor. a ug/l	S.D. m	Chlor. a ug/l	S.D. m	Chlor. a ug/l	S.D. m
1979						
May 1	6.5	2.0	4.4	1.9	6.1	1.9
May 24	11.9	1.8	12.4	1.8	8.8	1.8
May 31	23.9	1.6	14.9	1.5	39.4	1.5
June 7	26.5	1.7	28.0	1.6	11.8	1.7
June 14	17.3	1.5	11.1	1.5	15.1	1.6
June 21	9.7	1.6	10.3	1.5	9.9	1.5
June 28	9.4	1.3	7.5	1.5	9.7	1.8
July 5	22.6	1.3	22.0	1.3	29.6	1.3
July 12	10.8	1.3	18.1	1.5	20.4	1.5
July 19	4.4	1.7	4.9	1.7	5.5	1.8
Aug. 2	17.6	1.7	12.5	1.8	4.0	1.5
Aug. 9	20.6	1.6	23.1	1.5	--	--
Aug. 16	11.1	1.4	12.4	1.5	11.3	1.4
Aug. 23	7.5	1.5	10.4	1.4	14.0	1.5
Aug. 30	30.3	1.3	35.6	1.6	47.2	1.7
1980						
June 1			4.1	1.3		
June 9			3.9	1.5		
June 16			3.6	1.3		
June 30			3.9	1.0		
July 6			2.8	1.5		
July 13			1.9	1.5		
July 20			3.8	1.5		
July 27			6.2	1.5		
Aug. 4			3.8	1.0		
Aug. 10			7.9	1.3		
Aug. 17			8.3	1.5		
Aug. 24			9.2	1.0		
Sept. 1			6.9	1.3		
1981						
May 25	-	-	1.2	1.7		
June 8	-	-	3.1	1.7		
June 14	-	-	5.9	1.6		
July 12	-	-	4.2	1.9		
July 17			2.4	1.8		
July 26			3.1	2.0		
Aug. 3			7.1	2.0		
Aug. 9			5.0	1.8		
Aug. 17			4.6	2.0		
Aug. 24			8.3	2.0		
Sept. 7			11.3	1.2		
1982						
May 24	-	-	5.3	1.7		
May 30	-	-	3.9	1.7		
June 6	-	-	12.0	1.7		
June 12	-	-	5.1	1.8		
June 26	-	-	2.4	1.4		
July 4	-	-	4.7	1.5		
July 11	5.0	1.7	4.3	1.7		
July 1	4.6	1.5	5.7	1.5		
July 25	5.2	1.5	7.6	NA		
Aug. 2	8.9	1.5	5.1	1.4		
Aug. 18	8.8	1.3	7.5	1.3		
Aug. 15	7.5	1.3	-	-		
Aug. 25	-	-	NA*	1.3		
Aug. 29	4.5	1.5	-	-		

* Not Analyzed.

Table 3. Chlorophyll a (Chlor a in ug/l) and Secchi disc (S.D. in m) values for Stations WQ454, WQ455 and WQ456 in Dorothy Lake from 1979 through 1982.

Date	Station WQ454		Station WQ455		Station WQ456	
	Chlor. a ug/l	S.D. m	Chlor. a ug/l	S.D. m	Chlor. a ug/l	S.D. m
1979						
May 16	5.6	1.9	3.6	1.9	4.5	2.0
May 24	12.6	1.5	7.5	1.6	10.2	1.8
May 31	11.5	1.3	9.0	1.3	10.8	1.3
June 7	29.7	1.5	21.2	1.5	23.1	1.5
June 14	12.1	1.8	14.9	1.8	-	-
June 21	9.8	1.5	7.5	1.6	20.0	1.6
June 28	9.2	1.3	25.2	1.3	11.7	1.3
July 5	71.6	1.1	61.8	1.2	10.1	1.5
July 12	10.8	1.6	9.9	1.6	7.8	1.7
July 19	6.7	1.8	5.5	1.6	5.7	1.6
July 26	15.7	1.7	10.0	1.6	14.7	1.6
Aug. 2	10.7	1.5	11.6	1.6	13.8	1.5
Aug. 9	16.8	1.5	13.6	1.6	19.2	1.6
Aug. 16	7.2	1.3	8.8	1.5	10.7	1.5
Aug. 23	9.5	1.3	11.3	1.4	10.8	1.3
Aug. 30	17.2	1.4	25.0	1.6	39.6	1.5
1980						
May 19	6.6	1.8				
May 26	5.5	1.8				
June 1	2.0	2.0				
June 22	3.9	1.5				
July 1	3.1	1.3				
July 7	4.1	1.5				
July 14	2.2	1.5				
July 20	11.0	1.5				
Aug. 14	4.6	1.5				
Aug. 11	6.5	1.5				
Aug. 17	6.7	1.5				
Aug. 24	5.3	2.0				
Sept. 1	7.3	1.5				
Sept. 7	7.0	1.5				
1981						
May 31	-	-			6.2	2.1
June 7	-	-			2.7	1.8
June 14	-	-			3.7	1.8
June 21	-	-			3.7	1.7
June 28	NA	1.8			2.5	1.4
July 5	NA	2.0			NA	2.2
July 12	4.3	1.5			2.7	2.3
July 19	2.7	1.5			1.7	2.1
July 26	3.2	1.5			2.6	2.2
Aug. 3	-	-			4.9	2.0
Aug. 9	4.6	1.5			4.6	1.9
Aug. 16	-	-			8.6	1.9
Aug. 23	8.1	1.5			7.0	1.9
Aug. 30	-	-			6.8	1.9
Sept. 7	-	-			13.6	1.5
1982						
May 24	-	-			5.8	1.4
June 13	-	-			4.5	1.5
June 19	-	-			6.4	1.4
July 4	4.1	1.5			3.1	1.5
July 11	5.1	1.5			4.8	1.5
July 18	-	-			3.9	1.7
July 25	-	-			6.3	1.5
Aug. 2	-	-			8.0	1.4
Aug. 8	-	-			8.4	1.4
Aug. 15	-	-			6.5	1.0
Aug. 22	-	-			14.0	1.3
Aug. 30	-	-			5.8	1.2
Sept. 6	-	-			5.7	1.1

Table 4. Chlorophyll a (Chlor a in ug/l) and Secchi disc (S.D. in m) values for Station WQ586 in Margaret Lake during 1981 and 1982.

Date	Station WQ586 Chlor. a ug/l	S.D. m
1981		
June 7	3.2	2.8
June 14	3.7	3.0
June 28	4.2	2.8
July 5	6.9	3.8
July 12	4.9	4.0
July 19	1.3	2.8
July 27	4.3	2.0
Aug. 2	3.3	3.0
Aug. 9	5.6	1.7
Aug. 22	4.7	2.8
Aug. 30	7.2	2.8
Sept. 7	12.6	3.?
1982		
June 13	5.7	3.0
June 20	7.0	3.5
June 27	5.7	3.0
July 11	4.5	4.0
July 18	4.7	3.0
July 25	8.0	NA*
Aug. 15	5.5	2.5
Aug. 22	8.2	2.0
Sept. 6	5.7	1.1

* Not Analyzed.

Table 5. Chlorophyll *a* (Chlor *a* in ug/l) and Secchi disc (S.D. in m) values for Station WQ548 in Eleanor Lake from 1980 through 1982.

Date	Station WQ586 Chlor. *a* ug/l	S.D. m
1980		
May 25	8.4	1.5
June 13	2.5	1.0
July 27	5.1	1.5
Aug. 10	3.6	1.5
Aug. 17	5.5	1.3
Aug. 24	7.0	1.5
1981		
May 31	4.2	1.8
June 28	3.0	1.5
July 5	3.4	1.5
July 26	2.3	1.5
Aug. 3	1.5	1.6
Aug. 16	3.8	1.7
Aug. 24	1.6	1.8
1982		
July 25	2.0	1.9
Aug. 8	7.5	1.1
Aug. 15	5.8	1.1
Aug. 22	7.2	1.0

Table 6. Chlorophyll a (Chlor a in ug/l) and Secchi disc (S.D. in m) values for Stations WQ587 the Lee River as Pinawa Lake and WQ588 in Poplar Bay on Lac du Bonnet during 1981 and 1982

Date	Station WQ587		Station WQ588	
	Chlor. a ug/l	S.D. m	Chlor. a ug/l	S.D. m
May 31	9.6	0.8	-	-
June 7	12.0	0.8	14.0	1.3
June 14	12.0	0.8	16.0	1.3
June 21	-	-	8.5	1.3
June 28	5.8	0.8	6.0	1.3
July 5	-	-	NA*	-
July 26	-	-	16.0	1.0
Aug. 3	18.3	0.8	-	-
Aug. 23	8.3	1.0	-	-
Aug. 30	15.2	0.9	1.0	2.0
1982				
May 24	10.6	2.0	-	-
May 30	-	-	2.4	1.0
June 6	-	-	5.1	1.8
June 19	-	-	3.1	1.8
June 27	7.1	0.8	2.6	1.5
July 19	-	-	3.8	1.7
Aug. 2	-	-	2.4	1.0
Sept. 25	7.9	0.8	-	-
Oct. 3	6.4	0.8	-	-

*Not Analyzed.

Table 7: Mean annual chlorophyll a and Secchi disc (m) values and trophic state index (TSI) for each station on the Winnipeg River at, and between Pointe du Bois and Lac du Bonnet, 1979 through 1982.

LOCATION	STATION	1979				1980				1981				1982			
		Chlor. a (ug/l)		S.D. (m)		Chlor. a (ug/l)		S.D. (m)		Chlor a (ug/l)		S.D. (m)		Chlor a (ug/l)		S.D. (m)	
		Mean	TSI*	Mean	TSI*	Mean	TSI*	Mean	TSI*	Mean	TSI*	Mean	TSI*	Mean	TSI*	Mean	TSI*
Point du Bois	WQ584	-	-	-	-	-	-	-	-	6.5	48.9	2.0	49.9	5.7	47.6	1.5	54.1
	WQ585	-	-	-	-	-	-	-	-	-	-	-	-	6.7	51.2	1.6	53.1
Nutimik Lake	WQ459	16.6	58.1	1.6	53.3	-	-	-	-	-	-	-	-	-	-	-	-
	WQ458	15.2	57.2	1.6	53.5	5.1	46.6	1.3	56.1	5.1	46.6	1.8	51.6	5.8	47.8	1.6	52.9
	WQ457	15.3	57.4	1.5	53.7	-	-	-	-	-	-	-	-	6.4	48.7	1.5	54.4
Dorothy Lake	WQ456	14.2	56.6	1.6	53.7	-	-	-	-	5.1	46.5	1.9	50.7	6.3	48.5	1.4	55.4
	WQ455	15.4	57.4	1.5	53.9	-	-	-	-	-	-	-	-	-	-	-	-
	WQ454	16.0	57.8	1.5	54.3	5.4	47.1	1.6	53.2	4.6	45.5	1.6	53.2	4.6[a]	45.5[a]	1.5[a]	54.2[a]
Margaret Lake	WQ586	-	-	-	-	-	-	-	-	5.2	46.7	2.9	44.8	6.2	48.5	2.8	45.1
Eleanor Lake	WQ548	-	-	-	-	5.4	47.0	1.4	55.3	2.8	40.8	1.6	53.0	5.6[a]	47.5[a]	1.3[a]	56.5[a]
Lee River	WQ587	-	-	-	-	-	-	-	-	11.3	54.4	0.8	63.6	8.0[a]	51.0[a]	1.1[a]	58.6[a]
Lac du Bonnet	WQ588	-	-	-	-	-	-	-	-	10.3	53.4	1.3	56.0	3.2	42.0	1.4	55.1

* Carlson's (1977) Trophic state index.

[a] Less than 5 samples taken.

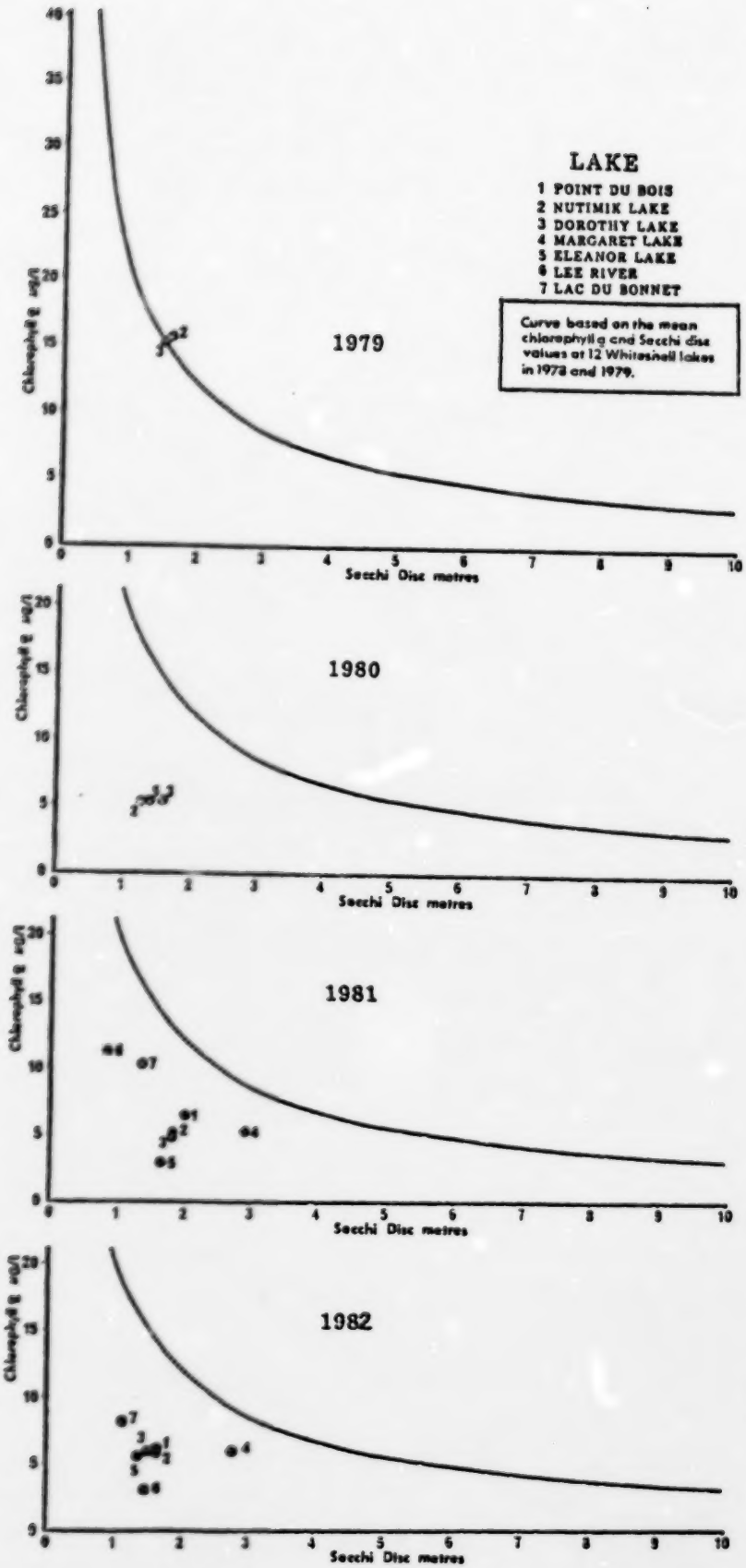

Figure 2: The mean chlorophyll a and Secchi disc values collected at six lakes and the Lee River on the Winnipeg River.

GLOSSARY OF TERMS

ALGAE - an assemblage of simple, mostly microscopic non-vascular plants containing photosynthetic pigments such as chlorophyll. Algae occur suspended in water (phytoplankton) and attached to rock and other suitable substrates. Some algae may produce nuisance conditions when environmental parameters are suitable for prolific growth.

CHLOROPHYLL - the photosynthetic green pigment which occurs in all groups of algae.

EUPHOTIC ZONE - the lighted region that extends vertically from the water surface to the level at which photosynthesis fails to occur due to insufficient light penetration.

EUTROPHIC - waters containing a rich supply of plant nutrients that support heavy growths of algae and aquatic plants. The increase in algae causes a decrease in the penetration of light. Deep areas may exhibit oxygen depletion due to the decomposition of dead organisms. Eutrophic lakes tend to be shallow and support warm water species of fish. The degradation in water quality renders the lake unsuitable for many recreational activities.

EUTROPHICATION - the process of becoming increasingly enriched in nutrients. It refers to the entire complex of changes which accompanies increasing nutrient enrichment. The result is the production of dense nuisance growths of algae and aquatic weeds which generally degrade water quality and render the lake unsuitable for many recreational activities. Accompanying the increase in algae is a decrease in game fish and an increase in coarse fish.

MESOTROPHIC - waters characterized by a moderate nutrient supply and organic production (i.e. midway between eutrophic and oligotrophic). The waters are suitable for most recreational activities.

OLIGOTROPHIC - waters containing a poor supply of plant nutrients resulting in little algae and aquatic plant growth. The waters are generally clear permitting extensive light penetration. Oxygen in the bottom waters is abundant. Oligotrophic lakes tend to be deep and support cold water fish such as lake trout and whitefish. The lakes are well suited for all types of recreational activities.

SECCHI DISC - a circular metal plate, 20 centimeters in diameter, the upper surface of which is divided into four equal quadrants and so painted that two quadrants directly opposite each other are painted black and the intervening ones white. The Secchi disc is used to estimate the depth of the euphotic zone.

TROPHIC STATUS - depending upon the degree of nutrient enrichment and resulting biological productivity, lakes are generally classified into three intergrading types: oligotrophic, mesotrophic and eutrophic. If the supply of nutrients to an oligotrophic lake is progessively increased, the lakes becomes more mesotrophic in character; with continued enrichment, it will become eutrophic.

µg/l - micrograms per liter or parts per billion.

LITERATURE CITED

CARLSON, R. E. 1977. A trophic state index for lakes. Limnol. Oceanogr. 22(2): 361-369.

Province of Manitoba. 1981. Public Health Act. Revised Regulations P210-R3, Division VII, Section 57.

POOR

QUALITY

ORIGINAL